NORTH DAKOTA'S COST-SHARE PROGRAM FOR GUARD ANIMALS

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ABSTRACT: Beginning in July 1991, the North Dakota Game and Fish Department authorized the use of funds in a cost-share program to assist farmers and ranchers with the implementation of nonlethal methods to protect livestock. Fund expenditures are administered and approved by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, North Dakota program. The program provides a 50:50 cost-share up to a maximum of $150 per purchase of nonlethal items for the protection of livestock from predation. During the six year period from July 1991 to July 1997, the program has cost-shared dogs, donkeys, electronic guards, and llamas. The Great Pyrenees dog breed was the method most frequently selected.

KEY WORDS: guard dogs, Great Pyrenees, Akbash, Maremma, llama, donkey, nonlethal

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INTRODUCTION

In the 17 western states the economic impact of predation on sheep exceeds $50 million annually (Connolly 1992). Methods used by livestock producers to reduce or eliminate predation consist of both of lethal and nonlethal practices. Lethal practices are usually implemented by professionals with experience in wildlife damage management because of federal and state regulations and because special skills are required. Nonlethal techniques are usually implemented by livestock producers and consist of preventive methods such as habitat modification, animal husbandry, and modifying animal behavior.

Animal husbandry practices generally involve modifying the level of care or attention given to livestock and include, but are not limited to: guard animals, herders, shed lambing, carcass removal, and fencing. Habitat modification alters habitats to attract or repel certain wildlife species or to separate livestock from predators. Modifying animal behavior refers to tactics used to alter the behavior of wildlife and reduce predation (e.g., fences, propane exploders, pyrotechnics, guard animals, or electronic guards).

Beginning in 1991, Wildlife Services (WS) entered into a cooperative reimbursable agreement with the North Dakota Game and Fish Department to reduce the loss of domestic livestock to coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*). The agreement provided two years of funding for cost-sharing of aerial hunting, and the cost-sharing of providing technical assistance and education to farmers and ranchers. Technical assistance included electronic scare devices, guarding animals, propane exploders, and other mutually agreed upon expenditures. The agreement has been renewed three times since its inception.

BACKGROUND

North Dakota encompasses approximately 45 million acres with the primary land use being agriculture. During 1995, North Dakota agriculture generated almost $3 billion in cash receipts (North Dakota Agriculture Statistics Service 1995). On less than 2 million acres of public grazing land during 1991, gross livestock sales generated $71.5 million (Bangsrud and Leistritz 1992). Consequently, livestock production plays an important role in North Dakota's economy.

Predation on livestock economically impacts producers. Predation on cattle occurs periodically throughout the year, whereas sheep are killed year-round. Consequently, individual sheep producers may suffer greater economic losses from predators than do cattle producers. The 1994 National Agriculture Statistics Service (1995) figures for North Dakota reported 4,000 sheep and lambs killed by predators. Coyotes were reported as the largest cause of predator loss accounting for 82% of the sheep and 89% of the lambs.

North Dakota averaged 164,667 sheep during 1993 to 1995 (North Dakota Agriculture Statistics Service 1995). Of the predation verified by WS employees in North Dakota during 1993, 1994, and 1995, coyote predation accounted for 96%, 95%, and 95% of the lambs and 100%, 64%, and 82% of the sheep, respectively.

METHODS

When a WS employee is called to investigate a possible incident of predation on livestock, he/she uses the Animal Damage Control Decision Model (Slate et al. 1992) to assess the problem, evaluate the currently employed methods, formulate a strategy, provide assistance, and monitor the results. WS assistance can be technical assistance or direct control or a combination of both methods.

As part of the technical assistance program, WS offers the producer an opportunity to participate in the cost-share program. The cooperative program provides funding on a 50:50 (WS:producer) basis with a maximum expenditure of $150 per purchase. For example, if the assistance cost $100, the producer would receive $50 or if the assistance costs $400, the producer would receive a maximum of $150. For the producers to claim a

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reimbursement, they have to submit to WS a form describing the item they purchased and a signed copy of the bill of sale. This paper pertains only to the data collected from the "Guarding Animal Cost Share Application."

RESULTS

During the six years the program has been implemented, sheep producers purchased 63 guard animals. Three producers purchased guard dogs to protect goats and one producer purchased a donkey (*Equus assinus*) to protect his horses and cattle. Eighteen producers did not report the type of livestock to be protected.

During the 1992-1993 biennium, 47 producers participated in the program purchasing 2 llamas (*Lama glama*), 9 donkeys, and 42 guard dogs. Producers reported purchasing burros and donkeys, but the names are used interchangeably (Green 1989b). For this paper the authors will use the name donkey. The average purchase price for a donkey was $236 with a range of $75 to $500. The price for each guard llama was $500. Great Pyrenees dogs were the breed of choice accounting for 95% of the selection and averaged $137 with a range of $47 to $300. One Akbash dog ($250) and one Maremma dog ($250) were also purchased.

During the 1994-1995 biennium, 22 producers participated in the program purchasing 0 llamas, 8 donkeys, and 19 guard dogs. The average purchase price for donkeys was $226 with a range of $50 to $600. Great Pyrenees dogs were again the breed of choice accounting for 95% of the selection and averaged $172 with a range of $55 to $300. A Maremma dog was also purchased for $300.

During the 1996-1997 biennium, 16 producers participated in the program purchasing 3 llamas, 4 donkeys, and 14 guard dogs. The average purchase price for donkeys was $194 with a range of $75 to $250. Llamas averaged $417 and had a range of $350 to $500. Great Pyrenees again outnumbered other breeds of guard dogs with 64% of the selection and averaged $191 with a range of $100 to $275. Akbash dog was the second most selected dog breed (29%) and averaged $537 with a range of $450 to $750. One Maremma dog was also purchased for $150.

Not all producers reported the size of their sheep herds. Of the 54 producers that used guard dogs to protect their sheep, the average size of sheep herd was 234 head (range 4 to 1,500). Eighty-eight percent of the guard dogs selected to protect sheep were Great Pyrenees. The average size of the sheep herd protected by Great Pyrenees was 234 head (n=48, range 4 to 1,500). The average size of the sheep herd protected by Akbash dogs was 271 head (n=5, range 200 to 500) and only one Maremma dog was reported as protecting sheep (45 head). The average size of the sheep herd protected by llamas was 512 head (n=5, range 87 to 1500) and the average size of the sheep herd protected by donkeys was 405 head (n=17, range 44 to 2,500).

Ages varied among the guard animals purchased. Great Pyrenees (n=48) ranged in age from 1.5 to 72 months with 75% less than 6 months (Figure 1). The median age for Great Pyrenees was 3 months and the mode was 2 months. The average age for Akbash dogs (n=5) was 7.4 months and ranged from 5 to 11 months. Maremma dogs (n=3) were aged 2, 3.5, and 8 months. Guard donkeys (n=21) ages averaged 45 months and ranged from 2 to 144 months (Figure 2). The average age for llamas (n=5) was 29.6 months with a range of 13 to 48 months.

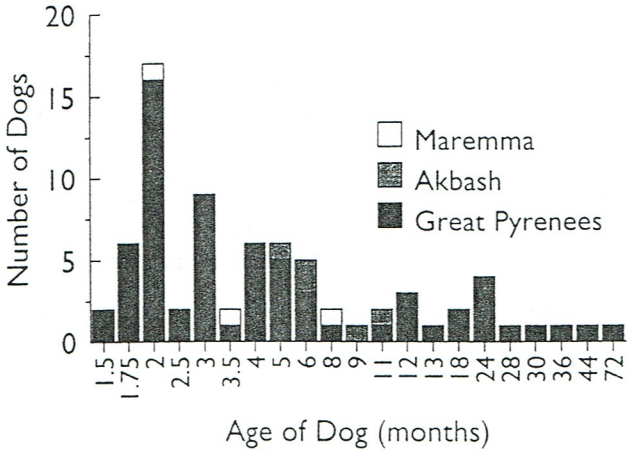

Figure 1. The age of guard dogs selected in the cost-share program in North Dakota during 1991 to 1997.

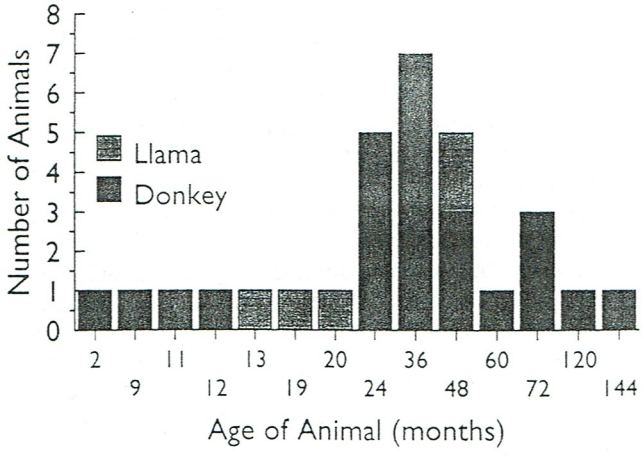

Figure 2. The age of guard llamas and donkeys selected in the cost-share program in North Dakota during 1991 to 1997.

Training of the guard animal varied from none to extensive on-the-job training. There was some confusion on the survey as to what type of training was to be reported. Some producers reported what education they or the seller had for training guard animals. Thirty-three Great Pyrenees (49%) were listed as having no training, while 25 (37%) had been raised with sheep (Figure 3). Eleven donkeys (52%) had some experience protecting flocks of sheep or goats and four individuals (19%) had been raised with sheep since birth (Figure 4). Sixty percent (3) of the llamas had some experience working with sheep.

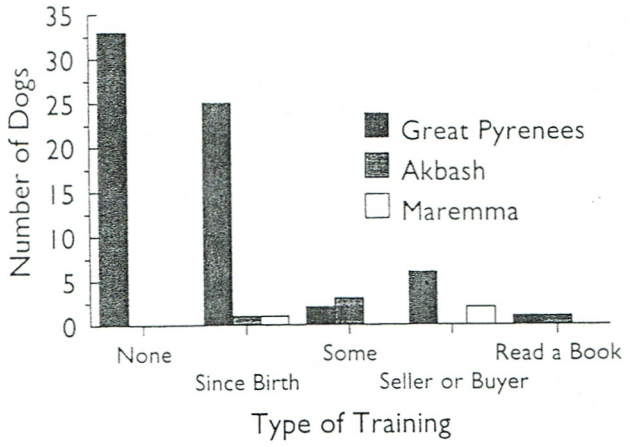

Figure 3. The type of training that individual guard dogs had when they were purchased by the cost-share program in North Dakota during 1991 to 1997.

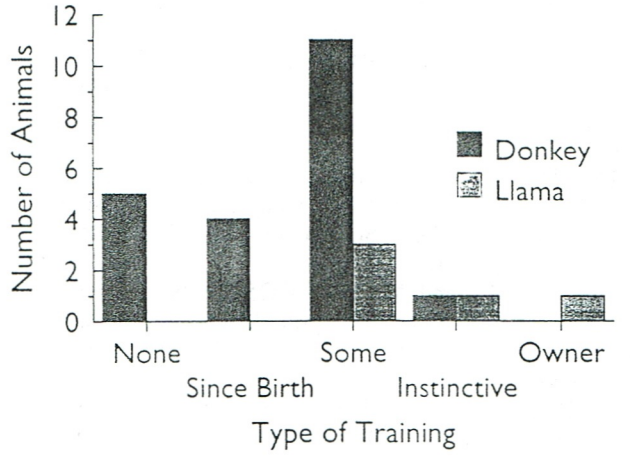

Figure 4. The type of training that individual guard llamas and donkeys had when they were purchased by the cost-share program in North Dakota during 1991 to 1997.

DISCUSSION

The use of guard animals enables producers to use grazing areas that were under utilized due to the presence of predators (Green and Woodruff 1996). Producers also become more self-reliant and gain other potential benefits such as: 1) reduced predation; 2) reduced labor; 3) improved potential for profit; 4) increased flock size; 5) protection of family members and other property; and 6) peace of mind (Green and Woodruff 1996).

Factors influencing the selection of guard animals include: cost, experience of the producer, size of herd, characteristics of the species or breed, maintenance of the species or breed, accessibility to breeders, time available for training, whether the guard animal is trained, and the availability of guard animals.

Nationally, 38% (± 1.4% SE) of sheep producers used guard dogs, 11% (± 0.9% SE) used guard donkeys, and 6% (± 0.6% SE) used guard llamas (U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services 1996). The national figures are comparable to North Dakota WS data for producers using WS where 34% (n=134) of the sheep producers and 30% (n=6) of the goat producers used guard dogs, 12.7% (n=50) of sheep producers and 10% (n=2) of the goat producers used guard donkeys, and 2.3% (n=9) of the sheep producers and 5% (n=1) of the goat producers used guard llamas (North Dakota Wildlife Services unpubl. data). But when given the opportunity to cost-share guard animals, livestock producers chose guard dogs (74%) over guard donkeys (21%) and guard llamas (5%).

Guard dogs have been used in North Dakota since the mid-1970s (Pfeifer and Goos 1982). During a 1981 survey, 96% of the guard dogs used in North Dakota were Great Pyrenees, and 4% were Komondor dogs (Pfeifer and Goos 1982). During the 1990s, Great Pyrenees (89%) are still the dog of preference, with Akbash dogs (6%) and Maremmas (4%) also being selected.

North Dakota livestock producers have stated their preference for Great Pyrenees because they mature at an earlier age, are less possessive and more mobile, easier to breed and to train (Pfeifer and Goos 1982). Additional studies have also stated that Great Pyrenees mature at an earlier age, are less aggressive towards livestock and family members, and are culled less often than other breeds (Green and Woodruff 1988; Green 1989a).

During the 1970s, the average cost of guard dogs in North Dakota was $590 (Pfeifer and Goos 1982). During the past 20 years, the average price of guard dogs in North Dakota has dropped to a low of $176 with individual guard dogs costing as little as $47.50. A reduction in purchase price could be attributed to the increased use of guard dogs in the United States and a subsequent supply of puppies from additional breeders.

Based on this survey, Akbash were at least twice as expensive to purchase as Great Pyrenees. The authors speculate that the reason producers were willing to pay more for a certain breed is similar to Colorado sheep producers who stated that Akbash were significantly more effective than Great Pyrenees (Andelt and Hopper 1997). They also rated Akbash as being more aggressive, more active, faster, and more intelligent than Great Pyrenees.

During the 1990s, the survey showed that 75% of Akbash had some form of training or experience prior to being purchased, whereas only 40% of Great Pyrenees and 33% of Maremmas had some form of training or experience. This is a change from the 1970s when ranchers were buying dogs with no experience for guard dog work (Pfeiffer and Goos 1982).

The age of guard dogs was not noted in Pfeiffer and Goos' (1982) 1981 survey. They did note that producers had the best luck with pups purchased at six weeks of age and raised with lambs. During this survey over 95% of the dogs and puppies purchased were more than seven weeks of age. Seventy-five percent of the producers showed a preference for purchasing puppies by buying animals that were less than six months old.

The average sheep herd size protected by guard dogs during the 1970s was 590 animals (Pfeifer and Goos 1982). Twenty years later, the average size of sheep herds protected by guard dogs has dropped more than 50% to 234 animals. The average size of sheep herds (405 head) protected by donkeys in North Dakota was almost twice the size of the average sheep or goat herd size (213 head) guarded by donkeys in Texas (Walton and Field 1989) and dogs in North Dakota. The average sheep herd size guarded by llamas was more than twice the sheep herd size guarded by dogs in this survey. The authors suggest caution when comparing the numbers provided on llamas and donkeys due to the small sample sizes.

Franklin (1993) stated that guard llamas which were gelded cost $700 to $800 and intact males were $100 cheaper. The average purchase price for llamas bought in the cost-share program was $450 with a maximum cost of $500. The authors suggest that the pricing of llamas, as with the pricing of guard dogs, follows the typical economic theory of supply and demand.

In a study conducted by Iowa State University, producers had good success with llamas averaging two years of age and no prior experience guarding sheep (Franklin 1993). The llamas purchased during this program were more than one year of age with the maximum age being four years. Fifty percent of the llamas purchased in the cost-share program had some experience as a guard animal.

The purchase price for donkeys in North Dakota ranged from $50 to $600 with an average price of $235.71. The North Dakota purchase price was higher than the price paid for donkeys in Texas which ranged from $75 to $150 dollars (Wilbanks 1995). The low purchase price of $50 was for an immature donkey purchased from a private seller and the high range was for an animal having experience with sheep. Seventy-one percent of the donkeys purchased in the cost-share program had experience with sheep or goats. The increased amount paid for a guard donkey in North Dakota vs Texas suggests that producers were willing to reduce their risk on an unproven feral animal by paying more for an experienced animal.

The cost-share program entered its fourth biennium on July 1, 1997. The program continues to offer producers a means to be more self reliant and use a wide range of techniques to manage predation.

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NON-LETHAL PREDATION CONTROL BY U.S. SHEEP PRODUCERS

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ABSTRACT: The USDA National Agricultural Statistics Service (NASS) surveyed U.S. sheep producers to determine the kinds of non-lethal (NL) predator control measures they used in 1994. An analysis of responses from 8,451 sheep producers showed that 34% of the nation's sheep producers used fencing, 25% used husbandry, 20% used guard animals, 4% used frightening tactics, 0.3% used aversion, and 3% used other methods. Because NL methods tended to be used more in large sheep operations than on small farms, the percentages of sheep protected by each NL control method were higher than the percentages of sheep producers using the method. Approximately 33% of all sheep in the U.S. were protected by fencing, 40% by husbandry, 39% by guard animals, 12% by frightening tactics, 2% by aversion, and 5% by other methods. Overall, 55% of U.S. sheep producers used one or more NL predator control methods in 1974, and 70% of the nation's sheep were protected by one or more NL methods.

KEY WORDS: Predators, predation management, sheep, non-lethal methods, fencing, husbandry, guard animals, frightening tactics, aversion

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INTRODUCTION

The U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) and Animal and Plant Health Inspection Service (APHIS) have cooperated on many surveys of wildlife damage to agriculture. Several national surveys have estimated sheep and goat (NASS 1991, 1995a,b) or cattle and calf (NASS 1992, 1996a) losses to predators and other causes. These studies have shown that the coyote is the most important predator of sheep and lambs in the U.S.

In January 1995, NASS asked sheep producers to report their predator control practices and expenditures during 1994. The results showed that fencing and husbandry practices were the leading non-lethal (NL) control measures used in that year (NASS 1995a). This brief summary did not estimate the percent of sheep producers who used each control method or the percent of sheep protected by specific methods, nor did it compare NL predation management practices on sheep operations of different sizes. The authors undertook additional analyses to obtain these estimates. The findings are summarized in this paper.

METHODS

NASS and its cooperating state agricultural statistics services surveyed a random sample of U.S. agricultural producers by mail, telephone, and face-to-face personal interviews in January 1995. All sheep and lamb producers, regardless of size, had a chance to be included in the survey; however, Alaska was excluded. Large producers were sampled more heavily than small operations. Producer responses were voluntary. Survey procedures and results were presented in detail by NASS (1995a,b).

Sheep producers who participated in this survey were asked which of the following NL predator control methods or groups of methods were used on their farms or ranches during 1994:

a. Husbandry practices (herders, corrals, carrion removal, pasture selection and grazing variation, habitat changes, season and location of lambing, etc.)
b. Frightening tactics (lights, bells, radios, propane exploders, strobe lights, sirens, etc.)
c. Aversion (repellents, aversive conditioning, etc.)
d. Fencing (net-wire, electric, etc.)
e. Guard animals (guard dogs, donkeys, llamas, etc.)
f. Other (specify)
g. No NL predator controls used

Sheep producers' responses (n = 10,798) to this survey were obtained, together with sampling weights, electronically from NASS. Weights were recalculated to account for 807 nonrespondents. Respondents (n = 531) who had no sheep on January 1, 1995 were dropped from further analysis. In addition, it was found that the records for 1,009 respondents were unusable because they failed to indicate whether or not respondents used NL control measures. The analysis was based on the remaining 8,451 responses.

It was hypothesized that the use of NL predation control methods would vary with the size of sheep operations, large producers being more likely than small operations to use such methods. To elucidate this, respondents were sorted into flock size classes based on the number of sheep and lambs on each farm on January 1, 1995. Four size classes were defined: class 1 = 1 to 49 sheep; class 2 = 50 to 199 sheep; class 3 = 200 to 999 sheep; and class 4 = 1,000 or more sheep.

Two weighted analyses were performed—one to estimate the percentages of sheep producers who used

173. Connolly, G.; Wagner, B. Non-lethal predation control by U. S. sheep producers. Proceedings, eighteenth Vertebrate Pest Conference, DoubleTree Hotel, Costa Mesa, California, March 2-5, 1998. Davis, Calif. : University of California, 1998: p. 126-130.

each method and another to estimate the percent of sheep protected by each method—using SUDAAN software (Software for the Statistical Analysis of Correlated Data, Research Triangle Institute Release 7.00, April 1996).

Percentages of respondents (unweighted data) and sheep producers (weighted) who used each NL method, or used no NL method, were estimated by state for each flock size class. Weighted percentages of sheep protected or affected by producers' use of each method were computed similarly. Similar estimates also were prepared for eastern and western regions of the U.S. and for the U.S. as a whole. Eastern and western regions were defined as APHIS Wildlife Services Eastern and Western regions. The eastern region includes Minnesota, Iowa, Missouri, Arkansas, Louisiana, and all states east of these; the western region consists of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas and all more westerly states.

The original report on this survey (NASS 1995a) noted that the results were subject to sampling variability but did not provide statistical estimates of variability. The authors quantified sampling variability by computing 95% confidence intervals (CIs) for each percentage estimate. Each CI was calculated as the estimate plus or minus a "t" value times a standard error (SE). Student's "t" values for $p = 0.95$ were obtained from a standard "t" table (Simpson et al. 1960:422). SEs for unweighted data were computed using the normal approximation for binomial distributions (Simpson et al. 1960). SEs for weighted estimates were provided by the SUDAAN software.

CIs were used to distinguish genuine differences from chance sampling variations. In general, it was considered any apparent difference between any two percentage estimates to be statistically significant when neither estimate was included within the CI of the other.

This analysis yielded a series of large tables that were too voluminous for presentation in this paper. The findings are summarized here, and are described in greater detail in Connolly and Wagner (1998).

RESULTS

This survey provided information about sheep producers' use of 6 NL predation control methods or method groups in 1994. Based on the authors' weighted estimates, 34% of the nation's sheep producers used fencing during 1994. Twenty-five percent used husbandry, 20% used guard animals, 4% used frightening tactics, 0.3% used aversion, and 3% used other methods. An estimated 45% of U.S. sheep producers used no NL predator control methods (Table 1).

Guard animals and frightening tactics were used by higher percentages of sheep producers in western states than in eastern states. Other methods were used by generally similar percentages of western and eastern producers, although large operations (size class 4) in the west used aversion at a higher rate than those in the east (Connolly and Wagner 1998).

A general pattern of association was seen between flock size and use of each NL method or method group (Table 1). The percentages of operators using each method were lowest for small flocks (size class 1), higher for intermediate size classes 2 and 3, and highest for large operations (class 4). Conversely, the percentage of producers who reported using no NL methods was largest for small flocks and smallest for large operators.

Weighted estimates for numbers of sheep revealed that 33% of all U.S. sheep were protected by fencing in 1994. Forty percent were protected by husbandry, 39% by guard animals, 12% by frightening tactics, 2.4% by aversion, and 5% by other methods. Overall, 70% of the nation's sheep were protected, and 30% were not protected by one or more NL predator control methods in 1994 (Table 2).

Except for fencing, the percentages of sheep protected by each NL method were greater in western states than in eastern states. Conversely, the percentage of sheep not protected by any NL method was 38% in eastern states, but only 28% in western states.

Estimated percentages of sheep that were protected by NL control methods tended to increase with flock size (Table 2). Except for fencing, the percentages of sheep protected by each method were lowest on small farms (flock size 1), higher in flocks of intermediate size, and highest on large operations (flock size 4). Fencing, in contrast, protected 37% of the sheep on both small and large operations, and smaller fractions of the sheep in operations of intermediate size.

For all NL methods except fencing, the percentage of sheep protected by each method (Table 2) was greater than the percentage of producers who used that method (Table 1). Consistent with this observation, only 30% of the nation's sheep were not protected by NL methods even though 45% of U.S. sheep producers used no NL method.

Unweighted survey data also showed different rates of use for the six control methods or method groups, as well as differences among flock size classes in the percentages of respondents who reported using each method (Connolly and Wagner 1998). For most control methods and flock size categories, the percentage of respondents who reported using the method was intermediate between the corresponding, weighted estimates for percentages of sheep producers (Table 1) and percentages of sheep protected (Table 2). These results are consistent with the sampling design that intentionally oversampled large operations (NASS 1995a).

DISCUSSION

The information presented in this paper is based on information from 8,451 sheep producers—10.3% of the nation's 82,120 sheep operations at the time of the survey (Table 1, footnote 1). This sample size is regarded as more than adequate to yield accurate information on predation management practices of the U.S. sheep industry. It should be noted, however, that the 1995 NASS survey did not question producers about all predation controls. It concentrated on NL control measures even though most sheep producers use both lethal and NL methods.

This analysis confirms the conclusions of NASS (1995a) regarding the relative frequency of use for various NL predation control measures. Fencing, guard animals, and husbandry were used most, frightening tactics and other methods less, and aversion was used very little.

Table 1. Use of non-lethal predation control methods by U.S. sheep producers in 1994.

Flock[1] Size	Non-lethal Methods and Methods Groups						
	Fencing	Husbandry	Guard Animals	Fright Tactics	Aversion	Others	No NL Method
	Percent of Producers Who Used Each Method[2]						
1	35 27-43	24 17-30	17 12-23	3 1-4	0.2 0.0-0.3	2 1-3	47 37-56
2	28 24-33	29 25-34	26 23-30	6 4-7	0.5 0.1-0.9	4 3-5	40 35-45
3	25 20-31	30 24-35	36 30-41	7 6-8	1.0 0.5-1.5	6 5-8	38 34-43
4	30 28-32	43 40-45	42 39-44	15 13-17	2.4 1.8-2.9	7 6-8	28 26-31
ALL	34 28-40	25 19-30	20 16-24	4 3-5	0.3 0.2-0.4	3 2-3	45 38-53

[1]Size class 1 = 1 to 49 sheep; 2 = 50 to 199 sheep; 3 = 200 to 999 sheep; and 4 = 1000+ sheep. On January 1, 1995, the United States had approximately 82,120 sheep operations (NASS 1996b). Their distribution by flock size was class 1—79.2%; class 2—14.3%; class 3—5.0%; and class 4—1.6%
[2]Hyphenated numbers are 95% confidence intervals.

Table 2. Percentages of sheep in the U.S. protected by non-lethal predation control methods in 1994.

Flock[1] Size	Non-lethal Methods and Methods Groups						
	Fencing	Husbandry	Guard Animals	Fright Tactics	Aversion	Others	No NL Method
	Percent of Sheep Protected by Each Method[2]						
1	37 30-43	27 20-33	20 14-26	3 2-4	0.2 0.1-0.3	2 1-4	41 35-47
2	28 24-31	30 26-34	28 24-32	6 5-8	0.5 0.2-0.9	4 3-5	39 35-43
3	26 19-32	31 25-37	37 32-43	7 6-9	0.9 0.5-1.3	6 5-8	37 32-41
4	37 34-39	49 46-52	48 45-51	18 16-20	4.0 2.8-5.2	6 5-7	22 20-25
ALL	33 31-35	40 38-42	39 37-42	12 11-13	2.4 1.8-3.0	5 5-6	30 28-32

[1]Size class 1 = 1 to 49 sheep; 2 = 50 to 199 sheep; 3 = 200 to 999 sheep; and 4 = 1000+ sheep. On January 1, 1995, the United States had approximately 8.886 million sheep and lambs (NASS 1996b). Their distribution by flock size was class 1—12.0%; class 2—13.9%; class 3—21.9%; and class 4—52.2%
[2]Hyphenated numbers are 95% confidence intervals.

This analysis went beyond that of NASS (1995a) in estimating the percentages of sheep producers who used each method and the percentages of sheep protected by each method. These estimates showed that most U.S. sheep producers used one or more NL predation management practices in 1994, and that about 70% of sheep in the U.S. were protected by one or more NL predation control measures. Both measures of NL method use were higher in western states than in eastern states.

The results of the analysis by flock size classes confirmed the hypothesis that NL predation controls were used more in large sheep operations than in small ones. In addition, weighted estimates reveal that the percentages of sheep protected or affected by the use of NL control measures were much higher than could have been inferred from the original report (NASS 1995a).

Comparing the authors' weighted estimates to the unweighted survey data, it was concluded that the unweighted statistics did not represent either sheep producers or sheep numbers as well as the weighted estimates. This finding seems logical, considering that the original analysis was not designed to estimate either the percentages of U.S. sheep producers who used various predation controls or the percentages of the nation's sheep industry that were protected by such methods.

It follows that reanalysis, including weighting as appropriate, is warranted whenever users of survey data want information that was not extracted in the original analysis. In this case, weighted analyses yielded useful information that was not presented in the original summary (NASS 1995a). NASS is commended for devising a recording system that preserved the original data in a form that was conducive to reanalysis.

An important finding in this survey is that many U.S. sheep producers reported using no NL predation control measures in 1994. As noted previously, the highest percentage rates of method non-use were on small operations (size class 1) and the lowest rates were on large operations (class 4; Table 1).

Why did not all sheep producers use NL predation controls? Part of the answer to this question, the authors believe, is that the risk of predation differs among sheep ranches. Balser (1974), for example, showed that approximately half of 111 ranchers interviewed in Utah and New Mexico had losses below 5% annually, while one-fourth reported over 10% predator losses. It is speculated that sheep producers' predation management efforts in 1994 varied with their perceived risk of predation. Those lucky producers who expected to have little or no predation probably did not devote major effort to predation control.

This study indicated that aversion was used by few sheep producers in 1994. "Aversion," as defined in the NASS questionnaire, included both repellents and aversive conditioning. No known repellents or aversive conditioning products that are effective and practical for protecting livestock from predators. None were registered or legally available in 1994, so it was not expected to have even small numbers of respondents to report the use of such materials.

As noted above, approximately 3% of U.S. sheep producers reported using "other" NL predation control measures. The "other" measures were not further identified in NASS (1995a) or in unpublished data available to the authors. They may have included shed lambing, harassment, scarecrows, and other practices that were not specified in "husbandry" or other method categories as defined in the survey instrument.

It should be recognized that the 1995 survey dealt rather superficially with sheep producers' predation management practices. Survey data based solely on producers' statements that they used or did not use specific methods give no weight to the quality or intensity of method use. A thorough analysis of predator management practices would entail better documentation of producers' level of effort with each method, coupled with assessments of effectiveness in reducing losses. The 1995 survey was a good start toward improved documentation of livestock producers' NL predation management practices, but much more remains to be done.

Another study of sheep producers' predation management practices was carried out in January 1996 as part of an animal health survey by APHIS's National Animal Health Monitoring System (NAHMS 1996a,b). This mail survey improved upon the 1995 NASS survey in two important respects—it included both lethal and NL predation control methods, and producers were asked for subject evaluations of method effectiveness. Approximately 66% of the operators used at least one lethal or NL predator management practice.

NAHMS' study found that 41% of U.S. sheep operations used one or more lethal methods, and 34% used guard animals. Among species of guard animals, llamas and dogs were rated as more effective than donkeys. However, the highest effectiveness rating went to "other" methods including night penning, other lights and noises, and "USDA:APHIS Animal Damage Control".

More recent NASS surveys also have recorded producers' assessments of predator control method effectiveness in selected states. Sheep producers in Colorado (CASS 1998) and Montana (MASS 1998) were asked to rate each of the NL control measures they used in 1997 as "very effective," "somewhat effective," or "not effective." The most effective methods in both states included herding, night penning, and shed lambing. Guard animals and fencing received higher effectiveness ratings in Montana than in Colorado. Similar data may have been collected in other states in 1998.

Perhaps the most detailed survey to date of livestock producers' NL predator management practices was carried out by APHIS Wildlife Services (WS) personnel in New Mexico in 1994. Livestock producers and other WS program cooperators were surveyed to determine what NL methods had been tried, how much it cost to implement the methods, which methods were successful, why some methods were discontinued, and whether lethal methods also were used to reduce agricultural and other property losses. The results were summarized by May (1996).

Livestock producers in New Mexico reported total expenditures of approximately $43.5 million on NL predation controls; most of these expenditures were for net wire fencing. Most of the NL methods implemented by livestock producers were still in use at the time of the

survey, even though many producers had discontinued using specific methods because they were ineffective or too costly. When New Mexico livestock producers were asked if specific NL methods they used reduced losses to an acceptable level, 80% of the responses were "no." Ninety percent of survey respondents used both lethal and NL methods.

Considering this study in conjunction with others cited in this paper, two basic conclusions seem to be warranted. First, most U.S. sheep producers use NL as well as lethal predation management methods. Second, livestock producers tend to select and use the control methods that they believe will be most practical and effective in their operations.

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